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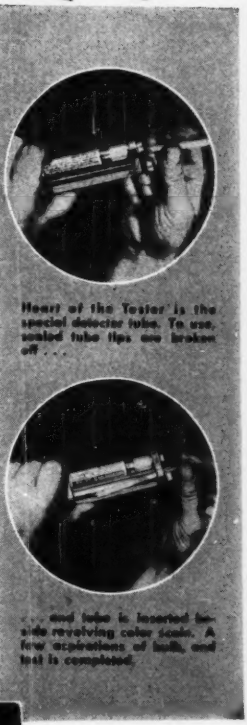

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AMERICAN
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Volume 10 DECEMBER, 1949 Number 4

Control of Environmental Industrial Hazards

ALLEN D. BRANDT
Bethlehem Steel Company
Bethlehem, Pennsylvania

THE HEALTH hazards in industry which, if uncontrolled, may cause occupational illnesses and discomfort, are many and varied. The more common ones may be divided conveniently into seven groups as follows: (1) Atmospheric contaminants (dusts, fumes, mists, gases, vapors and smokes); (2) Heat, cold, high humidity and rapid temperature changes; (3) Radiant energy other than heat; (4) Faulty illumination; (5) Noise; (6) Unsanitary conditions; (7) Fatigue.

All of these factors are capable of control by sound engineering to such degree as to render them innocuous to the industrial worker. It follows then that engineering is the first line of defense in the control of ill health and discomfort of industrial workers.

Fortunately for the engineering profession, the human being is a miraculous organism and can stand considerable mistreatment without showing illness or even discomfort. For this reason, noise, radiant energy, atmospheric contaminants, fatigue, etc., need not be completely eliminated, they need merely to be controlled within certain limits. These limits have been fairly well defined for most of the factors included in the foregoing list, and serve as bench marks for the engineers.

Of the groups listed in the first paragraph, the atmospheric contaminant group is the most important one. Because of its importance and the keen interest taken by labor and management, the engineering control of industrial atmospheric sanitation will be discussed in detail. No further reference will be made to the other health hazards, not because they are unimportant, but because of time limitations.

Presented at the Second Gulf Coast Regional Conference on Industrial Health, Houston, Texas, October 6, 1949.

Engineering Control of Atmospheric Contaminants

THE OBJECTIVE in controlling dusts, fumes, mists, smokes, gases and vapors is to prevent the amount in the air breathed by the workers from exceeding safe limits commonly called maximal allowable concentrations. They are not truly maximal allowable concentrations, but are the amounts which all but the unusually susceptible workers can endure day in and day out without producing significant effects on their well-being. These concentrations vary from material to material, some being relatively harmful and others being almost innocuous. Knowledge of the safe limits of the materials in question and how the amounts in the air can be measured is important to the engineer in addition to ways and means of reducing the concentrations.

Engineering measures for preventing the inhalation of excessively contaminated air have been discussed by many authors, and there are about as many different classifications of these methods as there are papers on the subject. The principles expounded, however, are always essentially the same. They may be divided conveniently into three main groups as follows, depending upon the avenue of approach:

1. Eliminating the sources of contamination or reducing the amount: (a) Design, alteration, and maintenance of buildings and equipment; (b) Substitution of less toxic materials; (c) Process or operation changes; (d) Housekeeping.

2. Prevention of contaminant dispersion: (a) Segregation of hazardous processes; (b) Enclosing the hazardous processes; (c) Wet methods; (d) Local exhaust ventilation; (e) Equipment maintenance; (f) Worker education; (g) Housekeeping.

3. Protecting the worker: (a) Equipment alteration; (b) General ventilation; (c) Respirators; (d) Worker education.

The control of an atmospheric health hazard is rarely accomplished by a single measure; it usually involves the use of a combination of methods.

Eliminating the Source of Contamination

OBVIOUSLY, the most successful approach to the problem of industrial atmospheric sanitation lies in *the design or alteration of plant and equipment* so that the control features are engineered into the structure and machinery. Factories constructed without due consideration to keeping the air clean, and existing plants, preclude the most efficient use of engineering-control knowledge. Much control equipment, installed on "unprepared" machinery even if carefully planned, is makeshift at best and has all the features of the proverbial "sore thumb."

Probably the most important single avenue to better atmospheric sanitation lies in the education of manufacturers of industrial equipment and machinery so that at least the basic elements of control equipment are included as an integral part of each machine which is known to produce or disperse dusts, fumes, smokes, mists, gases, or vapors. Some action in this connection is in progress, but the surface is only being scratched. Some new plants are being laid out with the atmospheric-sanitation problem in mind. Also a few industries which are undertaking industrial hygiene on a long-term basis are slowly mechanizing and modernizing their existing plants to increase production, eliminate arduous labor, and reduce atmospheric pollution. Fully as important as the original design of any piece of equipment is its maintenance. Deterioration, wear, corrosion, abrasion, and shock result in inefficient operation unless maintenance is good. In the smaller industry, maintenance is too frequently left to the user of the equipment. This is not a satisfactory procedure. All maintenance work should be made the responsibility of one man or one department.

A very effective method of control is *the substitution of nontoxic for toxic materials.* The application of this method is very limited in scope because of the basic requirements on which materials are usually selected. It should, however, always receive due consideration since it is both effective and usually inexpensive. Yet, for this very reason, the engineer or chemist must guard against overdoing substitution. It is generally agreed that any material, be it ever so harmful, can be handled safely if properly engineered. This feeling has been verified in practice by the experience of the atomic-bomb plants and the military explosives manufacturing and loading plants.

As substitution of less-toxic materials frequently runs counter to quality control in production it must be recommended with caution, particularly since other methods are available for the adequate control of hazards. Examples of successful substitution of less-toxic materials are the replacement of steel grit for sand in abrasive blasting; artificial abrasive grinding and polishing wheels for sandstone wheels; nonsilica parting compounds for siliceous compounds in foundries; petroleum naphtha or toluol for benzol in the lacquer, ink, and rubber cement industries; Stoddard solvent for carbon tetrachloride, in dry cleaning (special equipment is usually required to comply with fire regulations); quartz-free or low-quartz minerals for sand under mine locomotives; and relatively insoluble lead compounds for lead oxide in paints and ceramic glazes.

A change in the process can sometimes be used to eliminate or control a health hazard. Such change frequently involves major changes in other parts of the production line, and this control measure is therefore very limited in scope. Examples are controlling the temperature and speed of chemical reactions so that the rate of mist, gas, or vapor production is decreased; welding, crimping, riveting, or otherwise

joining to eliminate soldering operations; and changing from manual batch charging to machine and hopper charging.

More can be done by *good housekeeping* to eliminate sources of contamination, particularly dusts and fumes, than is commonly realized. In dusty industries or workrooms where dust is continuously settling on all surfaces which approach the horizontal, and collecting on vertical surfaces, good housekeeping in the form of vacuum cleaning, wet washing, and sometimes brushing prevents the material from being redispersed into the air.

The amount of dustiness which is contributed to the air of dusty industries by the continual redissemination of the settled material is sometimes more than 50% of the total dust concentration. Yet this dust can be prevented from getting into the air very readily by constant cleaning. Painting the walls a light color, improving the illumination, and oiling or wetting the floors are effective in promoting good housekeeping. While good housekeeping alone is seldom sufficient to control existing hazards, experience has shown that the housekeeping in most plants is a good index of the industrial hygiene program.

Prevention of Contaminant Dispersion

MANY INDUSTRIES have operations which produce considerable atmospheric contamination but which require the immediate attention of only a relatively small number of workers. If located indiscriminately throughout the plant or if conducted at certain times, such operations may expose many other workers to a needless amount of atmospheric contamination. By *segregating or isolating these operations*, only those few workers engaged there will be exposed to the hazard, and they may be protected by means of respirators. Also the segregation or bunching of hazardous operations aids materially in the effective application of local exhaust ventilation or other control measures.

The usefulness of this measure is so obvious that examples are scarcely needed. Blasting in mines at the end of the shift so that the gases and dusts will have settled or dissipated by the time the workers return, sweeping and cleaning at night when other workers are not on the job, shaking out foundry castings at night when most workers are off the job, and locating the plating or degreasing tanks in separate rooms are common examples.

Enclosing an operation might be considered an extreme form of isolation. The contaminant or contaminated air is prevented from reaching the breathing zone of any workers except in rare instances when one or two men may be exposed within the enclosure. It is superior to segregation or isolation since it acts nearer the source of contamination. In one instance the simple expedient of attaching a loose cover for the containers being filled to the end of a canvas discharge chute from a gyratory screen reduced the dust concentration in the screen room by well over 50%. In another instance a toxic and highly explosive material was transferred from 50 pound to five pound containers in a complete enclosure. The large cans were mounted on a frame in the top of a home-made enclosing device, and after closing the door the contents were dropped into a hopper by rotating the handle. Measured quantities were then dropped into small cans through a dust-tight corrugated hose. Two slide gates served to close and open the top and bottom of the measuring device. Hence by closing the lower gate and opening the upper one the material from the hopper filled the section between the slides which served as the measuring device. By closing the upper slide and opening the lower one the measured quantity of material was charged into the small container. This arrangement reduced the atmospheric concentration of the toxic material from a harmful level to almost nothing.

Process enclosure has been found particularly successful at abrasive-blasting operations, such as barrel and cabinet types of equipment which operate on the batch basis. The equipment is closed tight during the cleaning operation and is open only for charging and discharging after the abrasive blasting has been discontinued. This method of control does not find wide application except in conjunction with local exhaust ventilation which will be discussed later.

Wetting dust with water or other liquids is probably the oldest method of control. It was practiced in the pottery industry in Great Britain as early as 1713. Wet drilling and water sprays have been widely em-

ployed in mining operations in recent years. The use of water sprays in quarrying operations also has been reported recently. Substantial reductions in the dust concentration have been reported as wet-grinding operations, and as wet-drilling operations in mining, but even then the atmospheric concentrations were still greatly in excess of the maximal allowable concentration.

The effectiveness of wet methods for dust control depends upon two factors—wetting the dust, and proper disposal of the wetted dust. Some dusts are hard to wet and unless wetted will not be captured. Even if the dust is wetted satisfactorily, it is necessary to collect and dispose of the wetted material before the liquid evaporates and the dust is again redispersed by air currents, walking, or blasting. In certain mines, for example, the dust from the wet-drilling operations settles out as the water flows away, and collects also as water droplets on the walls from where it is readily redispersed. Even though wetting of the dust must be recommended with discretion, it has been found an effective dust control aid in rock drilling, blasting, crushing, screening, materials transfer, foundry shakeout, core knockout, and abrasive blasting, and the addition of moisture to molding sand decreases greatly any amount of dust produced while making molds.

Local exhaust ventilation is probably the most important single method of preventing industrial atmospheric pollution. Yet the principles involved and the bases for adequate design are so poorly understood that a large percentage of the installations made in recent years are unsatisfactory or inefficient. The design of good local exhaust systems is a specialty requiring knowledge not normally possessed by any engineering group including ventilating engineers, unless they have received special training in this field. This is neither the time nor the place, however, to discuss the details of this most important subject; they have been covered adequately elsewhere.[1,2,3] Suffice it to mention briefly the method of operation and to cite a few examples of operations at which local exhaust systems are used.

Local exhaust systems function by removing the contaminant or grossly contaminated air as close as practicable to the point where it is released or generated. This is done by producing air currents in the area of contaminant escape of such direction and magnitude as to carry the highly contaminated air into the exhaust hood which is located as close as possible to, or around, the source of contamination. The more nearly the hood encloses the source of contamination, or the closer it can be located to the source of contamination, the smaller will be the required exhaust rate to capture the contaminant effectively. Hood shape and location are of the utmost importance and deserve considerable study and head-scratching on the part of the designer. In addition to the hood, a local exhaust system includes piping or ductwork, an exhauster (usually a centrifugal fan), and usually a collector. The contaminated air is moved through the piping to the collector and the filtered air is then discharged to the outside of the exhauster. The design of the hood and piping, and the selection of collectors and exhausters are complete studies in themselves and will not be covered here.

Examples of the satisfactory use of local exhaust systems are numerous. Some are welding; granite surfacing; pickling and plating tanks; wood working equipment; grinders; buffers and polishers; and spray painting booths.

Like all other types of equipment, that are employed to control health hazards they require *constant checking and maintenance.* It should be included with other equipment in the cleaning and maintenance schedule. Dust collectors, fans and in many instances ductwork require periodic cleaning to obtain satisfactory operation. Bent hoods and leaky or damaged ductwork and enclosures should be repaired promptly. Blast gates and dampers, if used, should be locked in position, but even then they need constant watching to see that the setting is not altered by the workers and that the balance of the system is not thereby disturbed. Only too frequently management invests substantial capital in good control equipment and then, either through complacency or lack of understanding proceeds to forget all about it until faced with a case or epidemic of occupational illnesses. The answer, and the only way to protect their investment, is periodic checking and maintenance just as is done with production equipment.

Very few if any measures or installations for the control of atmospheric pollution are

foolproof. Much depends on the attitude of the worker. A cooperative, interested, and well-trained worker can accomplish much with any control equipment, whereas the indifferent, lackadaisical, untrained worker produces the maximal amount of atmospheric contamination with any control device.

The solution lies in the *education of the worker*. This is an unending task and becomes very discouraging if labor turnover is high. Nevertheless it is the key to the really successful operation of atmospheric sanitation equipment. As a rule the labor turnover will be much less if the working conditions are good. Therefore, proper education of the worker is the first step in a chain of events which lead to a satisfactory educational program. To be successful the education of the worker must begin the day he is employed. If he is permitted to begin his work without proper instruction in the performance of his tasks he will form faulty habits of operation which require much effort to undo. On the other hand the educational program must not cease as soon as the worker has been trained in the correct procedure of doing his job. It must be continued throughout his period of employment to keep him on his toes and to prevent him from falling into a faulty routine. Examples of what can be accomplished in atmospheric sanitation by worker education are unnecessary—they are quite obvious. Any operation (whether it be provided with control equipment or not) which produces or releases an atmospheric contaminant can be done, and should be done, in a manner which results in the escape of as little material as possible into the workroom air.

Good housekeeping will serve to prevent the dispersion of atmospheric contaminants. However, it is considerably more important in eliminating sources of contamination as was discussed previously in that connection.

Protecting the Worker

MOST INDUSTRIAL machinery or equipment which produces or releases harmful contaminants can be *engineered either in the original design or by alteration of existing installations* to decrease the worker's exposure. In many instances, however, the reduction of exposure is not sufficient to eliminate the hazard, and other control measures are needed. Yet there are some operations where the principle may be applied to render the worker's exposure harmless. Examples are the use of mirrors and/or extensions on operating handles to permit the worker to stand clear of the escaping contaminant; arranging all hot processes so that the operator stands beside rather than above the process; and locating a fan diagonally to the rear and to the side of the worker to blow the relatively clean workroom air through his breathing zone and to carry the highly concentrated contaminant from the operation he is doing away from him, or locating the terminal of a supply duct between the operator and the source of contamination to blow the contaminated air away.

General ventilation is second in importance only to local exhaust ventilation. It is particularly well adapted to certain contaminants and to certain sources of contamination but is unsatisfactory for others. Unlike local exhaust ventilation, it does not prevent the contaminant from escaping into the general workroom air, it merely dilutes the contaminated air of a given room or building with sufficient clean air to keep the concentration of contaminant in the room air from building up to a harmful level. Like local exhaust ventilation, general ventilation is misused a great deal by people who do not understand the fundamental principles of contaminant control. Major sources of contamination, especially if near to workers, cannot be controlled effectively by general ventilation; the dilution rate required to effect a safe concentration in the workers' breathing zones is so great as to be prohibitive. Minor and scattered sources of relatively harmless contaminants, on the other hand, may be controlled effectively and economically by general ventilation.

The subject of atmospheric sanitation through general ventilation is a very large and complex one. For further information on it, the reader is referred to treatises on the subject of which there are many.[1,4,5]

Respiratory protective devices have a distinct place in the field of occupational disease control. That they are a last line of defense can hardly be denied. Nevertheless, where they should be used, how they should be selected, and how they should be used and maintained is not understood adequately by some of the people whose re-

sponsibility it is to select them and supervise their use and care. Each and everyone assigned this responsibility should study some of the literature on this subject.[1,6,7,8] Examples of places where respirators may be used satisfactorily are spray painting; abrasive blasting; cutting metal coated with lead paints by means of oxyacetylene torches; welding; handling dusty materials; clean-out operations; shaking out operations in foundries; and housekeeping or other cleaning and sweeping.

The *education of the worker* for his protection is fully as important as to prevent the creation of unnecessary dust, fumes, mist, gases, or vapors. He must be told which contaminants are harmful and sold on the idea of avoiding the higher concentrations. Careful and continuous education is necessary to get workers in the habit of standing upwind of all operations which produce or release considerable material, such as spray painting, welding, cleanout and other maintenance operations, and handling bulk materials; also to keep his face as far from the point of operation as possible, or out of the line of throw or movement of the contaminant.

Examples of Results Obtained

IN CONCLUSION, I should like to cite one or two examples of the results achieved in decreasing occupational diseases through engineering. After all, "the proof of the pudding is in the eating."

In the gold mines of South Africa, dust concentrations averaged about 150 mg/m^3 before a program of control was begun and the reported incidence of miners phthisis was about 30%. About seven years after the dust control program was started the atmospheric dust level had been reduced to about 5 mg/m^3. The incidence of miners phthisis began falling about nine years after the dust control program was started and reached a level of about 2% approximately seven years after the dust level had been reduced to 5 mg/m^3. In this instance, the incidence of illness had been reduced from about 30% to 2% by reducing the atmospheric dust content from 150 mg/m^3 to 5 mg/m^3.[9]

An effective industrial hygiene program was launched in the government-owned explosives manufacturing and loading plants late in 1942—about one year after Pearl Harbor. The atmospheric concentrations of TNT were on the ascent at that time and continued to increase until about April, 1943 when they began to decline, the decline continuing until the close of the war. Periodic medical reports from these plants show that the incidence of lost-time cases because of TNT poisoning, of mild TNT poisoning cases, and of medical transfer from TNT exposure paralleled the atmospheric dust and fume levels very closely. The figures in this instance are somewhat as follows.

The peak concentration of TNT was about 2.7 mg/m^3 in April 1943 and the peak incidence of lost-time, mild, and medical transfer cases was about 21, 640, and 450, respectively, in terms of cases per thousand man years of exposed employees. The peaks of the cases occurred about July, 1943. By the end of 1944 the average atmospheric TNT concentration had been reduced to about 1.0 mg/m^3 and the corresponding incidence of TNT cases was 1, 80, and 85.[10] Engineering measures alone, of course, were not responsible for this entire reduction. The personal hygiene program, and the periodic medical examinations contributed substantially.

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Clarence Olds Sappington, M.D., Dr. P.H.

(1889-1949)

INDUSTRIAL HYGIENIST was DR. C. O. SAPPINGTON. From 1922 at Harvard School of Public Health to the day of his death, November 6, 1949, he was in the forefront of industrial hygiene development and practice. The first American recipient of the degree of Doctor of Public Health in Industrial Hygiene at Harvard, the first of a distinguished group to receive the WILLIAM S. KNUDSEN AWARD for the most outstanding contribution to industrial medicine, the Editor of INDUSTRIAL MEDICINE from its early years, he was always closely associated with progress in his chosen field.

Experience which formed the groundwork of his life's work of industrial hygiene consultation was acquired at National Safety Council to which he was called in 1928 as Director of the newly established Division of Industrial Health. From that time through the early thirties, the impact of the dust diseases hit the country and he responded to the consequent increasing demand. His "Silicosis: An Interpretive Review of Accumulated Experience," a monograph initially published in 1932, was an early comprehensive treatise on the subject.

By 1933, he had set up an independent consulting service. Not content with medicolegal and occupational medicine consultation alone, he extended his activities to the evaluation and control of health hazards.

On into the war years he was closely associated with most of the advances in industrial hygiene and a consistent attender of local, national and international conferences—more often than not he was on the program, and always he was a stimulating speaker. Delegate to a number of international congresses on industrial diseases, president of the CENTRAL STATES SOCIETY OF INDUSTRIAL MEDICINE AND SURGERY, President of the Chicago Section, AMERICAN INDUSTRIAL HYGIENE ASSOCIATION, director of a nationwide survey of health problems of women in industry, and later of a similar survey of industrial health departments under the auspices of the Industrial Hygiene Foundation of America; executive officer of the Committee on Workmen's Compensation of the American Medical Association Council on Industrial Health—these and many other related functions kept his program a crowded one. Yet he found time for prolific writings on industrial hygiene and allied subjects, and to author three books. His "Essentials of Industrial Health" will long remain an authoritative and useful textbook.

Music was DR. SAPPINGTON'S avocation. He took much solid enjoyment from the weekly (when in town) rehearsals and periodic concerts of the Chicago Businessmen's Symphony Orchestra of which he was long a member.

Always dynamic, enthusiastic, vigorous, something went out of him with the tragedy of the loss of his only son in World War II.

Over the last years DR. SAPPINGTON'S continuing great activity in all matters relating to industrial hygiene has been chronicled in his column "Dr. Pilgrim" appearing monthly in INDUSTRIAL MEDICINE. His wide friendship and acquaintance among industrial hygiene people is indicated by the many names appearing in the chronicle of those with whom he worked and associated.

And so we still feel his presence and will continue to do so whenever industrial hygiene matters are considered. It is with a real sense of loss that we observe the passing of C. O. SAPPINGTON, M.D., DR. P.H.—Industrial Hygienist.

Industrial Hygiene at Kennecott

R. T. PRING
Director, Industrial Hygiene Department
Kennecott Copper Corporation
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THE NATURE of an agency for the prevention of industrial health injuries depends largely on the understanding of those responsible for its policies as to what industrial hygiene really is. Accepting, for the moment, the concept that "industrial hygiene is the science and art of *recognizing, evaluating* and *controlling* potentially harmful factors in the industrial environment,"[1] what, in terms of plant operations, is the ultimate goal of an effective industrial hygiene program? Do "recognition" and "evaluation" together constitute industrial hygiene or is "control" the criterion of success or failure? Can these three phases of industrial hygiene be divorced one from the other and administered separately by separate, and often unrelated, agencies? These are some of the questions which face management in setting up the framework for an industrial hygiene program. The answers are not always the same, depending to a certain extent on the nature and organization of the industry to be served. At Kennecott an active industrial hygiene department capable of assuming responsibility for the program, from fact finding through to completed control measures, offers economic and other advantages best measured in terms of results accomplished.

Kennecott Copper Corporation

THE PRINCIPAL business of the Kennecott Copper Corporation is the mining of copper ores and the production of copper metal therefrom by concentrating, smelting and refining operations. Its domestic primary-producing divisions, four in number, are located in Arizona, New Mexico, Nevada and Utah, comprising in all some 16 plants exclusive of accessory operations such as power plants, shops, foundries and reagent manufacturing establishments. Operating under the general policies of the cor-

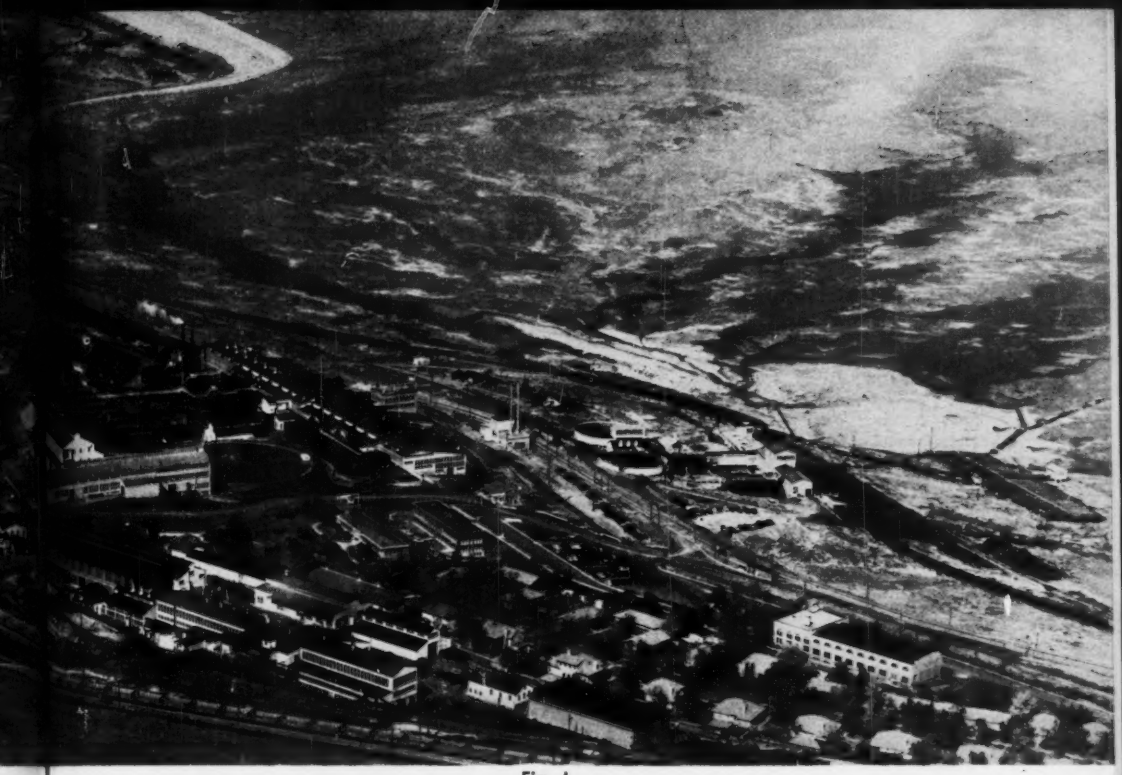


Fig. 1.
Arthur plant, Utah Copper Division, Kennecott Copper Corporation, Garfield, Utah. In left background: new Kennecott Utah Refinery, under construction

poration, each division is nearly autonomous and its general manager is supreme with respect to operations under his jurisdiction. Each division has its own highly competent engineering, medical and research departments so that such staff activities are highly decentralized with respect to the corporation as a whole. Worthy of mention is the excellent medical, surgical and hospital care provided for employees by the respective divisions and administered by company medical departments.

Functions of Industrial Hygiene Department

THE MANAGEMENT of Kennecott early recognized the desirability of industrial health protection of its employees, and industrial hygiene activities date back roughly 14 years at the Utah Copper Division, then the Utah Copper Company. More recently the present Industrial Hygiene Department was organized to serve all domestic primary-producing divisions of the corporation. It is a separate and distinct department maintaining equal relationships with all divisions regardless of size or location. Headquarters are located at Garfield, Utah, approximately 20 miles west of Salt Lake City, and field work in Utah and Nevada is based there. At Hurley, New Mexico, is located a branch laboratory from which field engineering for the southwestern divisions is conducted. In general, our responsibility is the working environment with relation to its effect on the worker. Factors contributing to the entity comprise dusts, fumes, vapors, gases, toxic materials, heat and humidity, noise and vibration. Functions of the department may be classified according to the definition of industrial hygiene appearing above; i.e., fact finding (recognition), evaluation and coordination, and prevention (control) as follows:

Fact finding comprises plant surveys and the usual chemical and physical procedures for the quantitative evaluation of the working environment. Except in emergencies, samples other than for dust counting are forwarded to headquarters for analysis, and reports of findings are submitted to all interested persons. Routinely-used equipment is maintained at headquarters and at the

KENNECOTT COPPER CORPORATION

X-Ray Date..... Chino Mines Division Nevada Mines Division Division .....
X-Ray No. ..... Ray Mines Division Utah Copper Division Plant .....
Phy. Exam. No. ..... INDUSTRIAL HEALTH SURVEY Pre-emp. .....Periodic.....

APPLICATION FOR X-RAY EXAMINATION

Name .....P. R. No. .....Age.....
Nationality ..... Married or Single .....No. of Children.....
Address .....S. S. No. .....
Occupation .....Department .....
Duties .....
Height..... Weight..... Chest Exp. .....In..... Ex. Exposure .....M.P.C.F.
Ft. In. Lbs. Inches
Length of Employment ....
In present department Total with company
Previous X-Ray No. ..... Date .....
Remarks .....
Medical History .....
Chest X-Ray Diagnosis .....
Remarks .....

1. Previous Dust Exposure		Rating	
2. Total Dust with Co.		Condition	
3. Total Dust Exposure		Degree	
4. Coarse Crushing		Accuracy	
5. Fine Crushing, Dry		Change	
6. Fine Crushing, Wet		Disability	
7. Repairs, Dusty & Noc		Date Last Hired	
8. Repairs, other than 7		Disposition	
9. Oilers		Reason	
10. Ball Mill		Re-Examine Date	
11. Sampling Department		No. X-Rays	
12. Clean-up			
13. Foundry			

Re-examine Date .....

.....
Examining Physician

Recommendations .....

Card Completed .....

.....
Director, Industrial Hygiene Department

Fig. 2(a).

OCCUPATIONAL HISTORY

From Date	To Date	Occupation	Name and/or Location of Employers	Remarks

I certify that I have read the above and that all statements made by me in connection therewith are to my best knowledge and belief true and correct.
The findings of the doctor may be revealed to the appropriate officer or agent of Kennecott Copper Corporation.

.....
Interviewer (Witness)

.....
Employment Director

.....19.. .....
Date Applicant

Fig. 2(b).

(a) Front and (b) back of report form used by industrial hygiene department for central records of chest x-ray and occupational data

southwest laboratory; special apparatus is located at the home office and made available where needed.

Dusts of various types are the atmospheric contaminants most commonly encountered in the various plants; however, carbon monoxide, carbon disulphide, sulphur dioxide, sulphur trioxide, lead and other metal fumes, organic sulphur compounds, higher alcohols, solvents, radiant heat, high humidity, noise and vibration, while of lesser importance, are nonetheless present in certain instances and require study.

As a matter of common sense, certain analyses requiring expensive equipment or highly specialized training are contracted out to other laboratories, i.e., x-ray diffraction and spectrographic analyses. Cer-

tain types of research involving animal experimentation have been turned over to the medical school of a nearby university with which a close relationship is maintained.

Evaluation and coordination are the administrative phases of industrial hygiene, involving (a) the correlation of environmental findings with data on the physical condition of groups of employees, (b) the evaluation of the environment in the light of available facts and (c) the coordination of preventive measures.

As an engineering organization we work cooperatively with, and in an advisory capacity to, local medical departments, which are responsible for all medical work. We give them copies of all reports and full information as to plant conditions. In return the medical staffs furnish reports of findings from their pre-employment and follow-up examinations, limited, however, to conditions having industrial implications. Occasionally special examinations of groups of employees are suggested by the Industrial Hygiene Department.

We prepare and analyze statistical data on health and the environment, and to this end central records, particularly on chest x-ray interpretations and occupational histories, are maintained at headquarters. Figures 2a and 2b illustrate one type of report, as received from all divisions, from which data are coded and transferred to punch cards for machine tabulation.

Once all facts are assembled and correlated, an evaluation of the environment may be made and the need for preventive measures determined. Very frequently comfort, rather than any health hazard, is the basis for recommending plant improvements.

Coordination of preventive measures usually entails conferences with operating and maintenance officials, or, in some cases, top management, at which the most effective and economical improvements are mutually agreed upon. This approach eliminates cross-purposes and insures the cooperation of all interested parties. It also makes available to the solution of a given problem the sum total—such as it is—of our experience at all plants of the corporation. On rare occasions a situation is encountered where engineering methods of control are, for various reasons, not possible. In such cases, medical staffs are contacted so that preventive medical procedures may be inaugurated for the protection of those exposed.

Prevention or control of potentially harmful environmental conditions is our major objective and no project is considered completed until effective control measures are in operation. The approach to a given problem is worked out—often experimentally—with proper officials by the field engineers, except that where ventilation is required the job is referred to headquarters. Drawings of new construction are also furnished to us in order to permit advance planning of health protective measures. Our ventilation design section prepares complete general arrangement drawings and specifications for such local or general exhaust, air supply and air conditioning systems as may be required in the various plants. Detailing is done by local engineering departments, who have available sample plates of standard details furnished by our department. Construction is also the responsibility of local offiicals with the advisory assistance of the industrial hygiene engineers.

Centralization of ventilation design work has worked out very well, we believe, because it is possible to maintain a staff of specialists in that field who can apply fundamental engineering principles to their designs. Here again the accumulated experience of the group is made available to each division, and the savings in avoiding duplication of effort is considerable.

While respirators and masks of various types are less than satisfactory hygienically, there are many instances where their use is required. Ranging from complete programs for selection, allocation and maintenance of this equipment at some plants to advisory services at others, the Industrial Hygiene Department maintains an active interest in providing the best available protection of this type.

Miscellaneous Duties

OCCASIONALLY the Industrial Hygiene Department is requested to undertake a special project by one of the divisions, usually involving atmospheric pollution or meteorological studies for plant site selection. Properly-qualified personnel is retained on a temporary basis in such instances.

Safety hazards coming to our attention

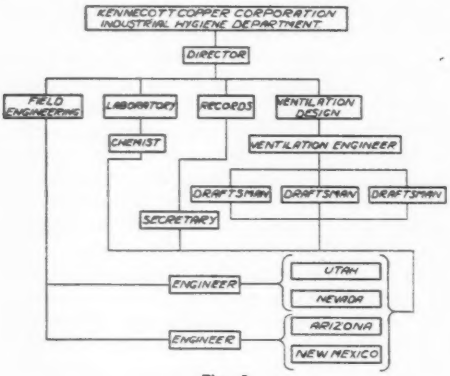


Fig. 3.
Organizational flowsheet of Kennecott's industrial hygiene department

during our plant inspections are referred to the safety engineers with whom close relationships are maintained.

Personnel, Costs and Facilities

THE presently-authorized staff of Kennecott's Industrial Hygiene Department comprises nine persons, as follows:

Title	Number
Director	1
Supervising Industrial Hygiene Engineer	1
Field Engineer	1
Industrial Hygiene Chemist	1
Supervising Ventilation Engineer	1
Ventilation Draftsmen	3
Secretary	1
Total	9

Figure 3 shows our organizational flow sheet. With the exception of one engineer at the southwestern laboratory, all personnel is based at headquarters.

The cost of Kennecott's industrial hygiene program is paid by the four divisions in the form of (a) pro-rated overhead expense and (b) direct charges which cover ventilation design and other specific projects. In apportioning overhead costs among the divisions, indirect expenses are billed in ratio of nominal tonnages of ore mined at each location. We hope to eliminate eventually this method of financing our work in favor of a single charge based on plant populations. At some plants preemployment and follow-up chest x-ray expense is charged to the industrial hygiene program since it is not a part of the medical care cost to which employees contribute.

Office and laboratory facilities are located at the Magna plant of the Utah Copper Division and comprise director's and general offices, general, chemical and heavy equipment laboratories, drafting office, and special instrument and microscope rooms. Travel to other plants is mostly by automobile.

Supervision

THE INDUSTRIAL Hygiene Department is responsible to the general manager of each division for all activities in connection therewith; otherwise it reports through the director to the General Manager of Western Operations. In practice, our work in any plant is subject to the supervision of the superintendent or department head having jurisdiction over the particular operation involved. Particularly in preventive engineering, we have found that we must work from the bottom up, not from the top down. The department foreman and the men who operate the machines can tell us what can be done without interference to the process, and their cooperation is highly essential. The superintendent must approve the final plan as well as authorize the project in the first place; if he does not like what we propose, he is at liberty to seek another remedy. We are assured only that we will be given opportunity to submit our ideas before other action is taken.

Like any other, Kennecott's Industrial Hygiene Department has responsibility but little authority, and our approach to any problem is one of sales engineering.

Acknowledgments

NO PROGRAM of this sort can hope to succeed unless it is carried out in the spirit of fullest cooperation among all persons and departments involved. It is fitting to state here that such cooperation on the part of operating, engineering and medical staffs has been of the highest order.

Reference

1. PATTY, FRANK A.: General Motors Industrial Hygiene Service. *A.I.H.A. Quarterly*, 7:3, p. 3 (September, 1946).

Tabulation of Toxicity Classes

A Report Prepared by
HAROLD C. HODGE† and JAMES H. STERNER*
from Notes Taken at the Toxicological Round-Table

THE discussions of the Toxicological Round-Table during the past three years have been based on the recognized need for a healthy degree of standardization in toxicological terminology and in methods of testing. There have been several aspects of the development of this idea. One of these concerns the classification of degrees of toxicity; the current report summarizes our thinking and points out some of the needed further developments. We have taken it upon ourselves to prepare this summary for a group which included the following: H. F. SMYTH, C. P. CARPENTER, D. D. IRISH, V. K. ROWE, W. B. DEICHMANN, J. H. DRAIZE, W. F. VON OETTINGEN, C. I. BLISS, O. M. GRUHZIT, H. BRIEGER, E. A. MAYNARD, E. M. ADAMS, R. A. KEHOE, F. F. HEYROTH, L. T. FAIRHALL, L. C. MILLER, H. E. STOKINGER, A. J. LEHMAN, F. R. HOLDEN, and others.

At the A.I.H.A. meeting in April, 1947, in Buffalo, a series of terms was proposed to describe the toxicity of industrially-important chemicals. These terms were to be given a special technical significance so that —among industrial toxicologists—dosage and descriptive terms would be codified. Six ranges of toxicity beginning with the most toxic compounds might be described as follows: (1) extremely toxic, (2) highly toxic, (3) moderately toxic, (4) slightly toxic, (5) practically non-toxic, and (6) relatively harmless. To give these categories a significant reference, the probable lethal dose for man in common units of measurement are given in the accompanying table.

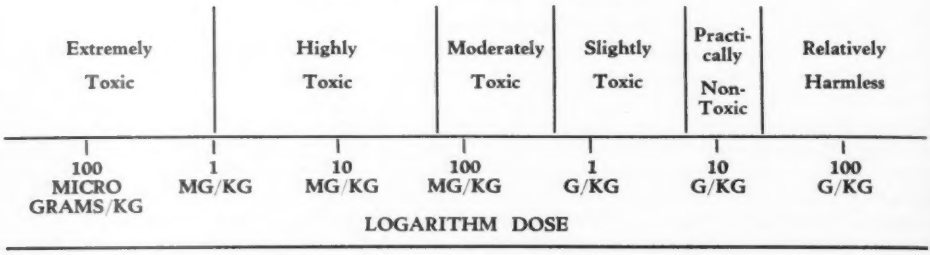
It is obvious that if a drop or a grain of any substance is capable of causing death, it is 'extremely toxic.' The next common unit of measurement is a teaspoonful. A substance which in this small dosage would cause death would certainly be 'highly toxic.' If an ounce were required, it seems reasonable to describe such a material as 'moderately toxic,' whereas a lethal dose of a pint might be described as 'slightly toxic' and a quart as 'practically non-toxic.' There are relatively few materials in which a lethal dose is greater than a quart and it seems that such material could properly be designated as 'relatively harmless.' In other words, the descriptive terms logically and easily fit the amounts commonly dealt with as units of measurement. What we propose is that for various routes of administration, for example, orally, intraperitoneally, by lung, or by skin, and for specifically stated species, these common terms be defined *by industrial toxicologists* as referring specifically to doses effective within the defined ranges.

The industrial toxicologist has at least two problems in describing the poisonous character of chemicals handled in his plant. In the first place he must describe the toxic properties in some simple way that is understandable to other toxicologists. Since this tabulation of toxicity classes was first made a little over a year ago, it has been applied to results of toxicity testing and has been found to fill, at least for us, a long-felt need for a simple, understandable expression of the degree of toxicity. It not only has helped as a descriptive language but, in comparing the results of toxicity tests on a sizable list of compounds, these categories have materially assisted in organizing and presenting the data.

The second problem which the industrial toxicologist continuously faces is his responsibility to the plant operators and management in the translation of toxicity data into terms of 'hazard.' This translation must be in terms that will immediately and clearly describe the precautions to be used in handling the material. One very active laboratory has used the device of naming toxic substances in each hazard category so that when a new substance is investigated, it is only necessary to relate it to the few well-known materials, the handling properties of which are well-established. Since only rarely would such 'common denominator' or 'reference' compounds have

†Division of Pharmacology and Toxicology, University of Rochester
*Medical Department of Eastman Kodak Company

GRAPH OF TOXICITY CLASSES



sufficient familiarity from industry to industry, we would suggest that the typical substances—if selected to represent handling properties—should be so simple and so widely available that each laboratory and plant could recognize the special properties of these substances without extensive investigation. *For the purpose of this discussion, we wish to disregard the categories of 'hazard' and to restrict attention solely to those of 'toxicity.'*

The selection of the exact numerical dosage in mg/kg which defines the ranges corresponding to the terms are arbitrarily chosen. There probably would be as many ranges as people who would select them. In the accompanying figure, the ranges are plotted graphically on a logarithmic scale and it can readily be seen that the various categories, while differing somewhat, are surprisingly comparable in length. This reasonably regular division of the logarithmic range coupled with the fact that the probable lethal dose for man, progressing from a drop or grain to more than a quart, is the approximate mid point of each division, would seem to us a practical division of the toxicity scale. See text table.

At the A.I.H.A. meeting in Boston in April, 1948, the tabulation was discussed briefly and the need for a compilation of information already available in the literature was clearly indicated. During the past year, DR. ROBIN RANKOW has been collecting specific data in a literature survey; the accompanying tables have been prepared by him. These are offered, not as ideal examples, but as the best at hand. They are offered in the hope that these tabulations will provide the opportunity for better type substances to be suggested.

TEXT TABLE

Toxicity Rating	Category	Single Oral Dose	Probable Lethal Dose for Man
1	Extremely toxic	1 mg or less/kg	A taste 1 grain
2	Highly toxic	1—50 mg	1 tsp. 4 cc
3	Moderately toxic	50—500 mg	1 oz. 30 g
4	Slightly toxic	0.5—5 g	1 pint 250 g
5	Practically non-toxic	5—15 g	1 quart
6	Relatively harmless	15 g and more	> 1 quart

The table on oral administration gives the LD_{50} doses for rats in g/kg. Sodium fluoroacetate was the best example of an extremely toxic substance. In fact, very few substances were found of which less than a mg/kg was rapidly fatal. The highly toxic substances, sodium fluoride and ethylene imine, are believed to be widely known as are most of the examples given in the other categories. Comparative data from a few other species are included.

The same terms have been applied to the description of intraperitoneal administration, with, however, a shift of dosage toward smaller values by a factor of 2 to 10 (or approximately one class unit). This relationship was chosen arbitrarily on the basis of limited data and may well need revision when more evidence is accumulated.

The compounds listed in the table covering lethal effects after intraperitoneal administration are duplicates, in some cases, of those in the oral toxicity table. This was felt to be a desirable feature. The exact toxicity of aminopterin in rats is a needed figure. The highly toxic nitrogen mustards were selected as the type substances for this category and it is interesting to note that mustard gas and di-isopropyl fluorophosphate, two of the moderately toxic substances, are also chemical warfare agents. The other compounds listed are, in

Oral Administration (GM/KG)

Category	Rats	Other Species
Extremely toxic	Sodium fluoroacetate (0.0001)[1]	Sodium fluoroacetate (50 μg); dogs[10]
Highly toxic	NaF (0.047)[2] Ethylene imine (0.015)[3]	NaF (0.023—0.90); rabbits[12] NaF (0.05—0.1); dogs [11]
Moderately toxic	DDT (10% in oil—0.3)[4] 4, 6 dinitro-o-cresol (0.05)[5]	Acetanilid (0.25); cats[6] DDT (5% in oil—0.3); cats, rabbits[12]
Slightly toxic	Acetanilid (0.8)[6]	Acetanilid (1.5); rabbits[6] Acetanilid (1.4—1.5); guinea pigs[6] Acetanilid (0.75—1.0); dogs[6]
Practically non-toxic	PABA (Para aminobenzoic acid) (>6)[1] Diethylene glycol monoethyl ether (30.6)[7]	PABA (1—3); dogs[5] PABA (2.85); mice[8]
Relatively harmless	Di (2-ethyl hexyl) phthalate (30.6)[9]	Di-2 ethyl hexyl phthalate (33.9); rabbits[9]

1. Chenoweth and St. John: *J. Pharm. Exp. Therap.*, 89:76, 1947. 2. Roholm, K.: "Fluorine Intoxication." Lewis & Co., Ltd., London, 1937. 3. Smyth et al: *J. Ind. Hyg. & Tox.*, 23:259, 1941. 4. Philips and Gilman: *J. Pharm. Exp. Therap.*, 86:87, March, 1946. 5. Spencer et al: *J. Ind. Hyg. & Tox.*, 30:10 1948. 6. Munch, Pratt and Phillips: *J. Am. Pharm. Assn.*, 30:91, 1941. 7. Hanzlik, P. J., et al: *J. Ind. Hyg. & Tox.*, 29:190, 1947. 8. Scott et al: *Proc. Soc. Exp. Biol. & Med.*, 49:184, 1942. 9. Shaffer et al: *J. Ind. Hyg. & Tox.*, 27:130, 1945. 10. Chenoweth and St. John: op. cit. 11. Leake, C. D.: *J. Pharm.*, 33:279, 1928.

Intraperitoneal Administration (GM/KG)

Category	Rats	Other Species
Extremely toxic	Aminopterin	
Highly toxic	Nitrogen mustards (0.0005—0.001)[15]	Nitrogen mustards (0.001—0.002); mice, rabbits[15]
Moderately toxic	NaF (0.013—0.016)[1] Mustard gas (0.003)[17] Di-isopropyl fluorophosphate (0.0002)[16]	NaF (0.23—0.045); dogs, rabbits[1] Mustard gas (0.006—0.008); mice, rabbits[17] Di-isopropyl fluorophosphate (0.0004—0.003); monkeys, mice, rabbits, cats, dogs[16]
Slightly toxic	Ethylene chlorohydrin (0.05—0.06)[5] Methyl bromide (0.12—0.28)[6] BAL (0.105)[13]	Diethyl phthalate (I.V., 0.1); rabbits[8] Phthalic acid (0.55); mice[10] BAL (0.1); mice[14]
Practically non-toxic	Acetaldehyde (0.5)[2] Choline (0.29—0.34)[3] PABA (P-aminobenzoic acid) (4.0)[11]	Choline (0.32); mice[4] PABA (I.V., 2.0); rabbits[12]
Relatively harmless	Diethyl phthalate (30.7)[7]	Diethyl hexyl phthalate (128); mice[9]

1. Roholm: "Fluorine Intoxication." Lewis & Co., Ltd., London, 1937, p. 16. 2. Stotz, Westerfeld, and Berg: *J. Biol. Chem.*, 152:41, 1944. 3. Hodge: *Proc. Soc. Exp. Biol. & Med.*, 57:26, 1944. 4. Hodge and Goldstein: *Proc. Soc. Exp. Biol. & Med.*, 51:281, 1942 . 5. Goldblatt: *Brit. J. Ind. Med.*, 1:213, 1944. 6. Millar and Haggard: *J. Ind. Hyg. & Tox.*, 25:423, 1943. 7. Shaffer, Carpenter, and Smyth: *J. Ind. Hyg. & Tox.*, 27:130, 1945. 8. Flury and Wirth: *Arch. Gewerbepath.*, 5:1, 1933. 9. Hodge, H. C.: *Proc. Soc. Exp. Biol. & Med.*, 53:20, 1943. 10. Hodge et al: *Proc. Soc. Exp. Biol. & Med.*, 49:471, 1942. 11. Richards: *Fed. Proc.*, 2:71, 1942. 12. Anigstein and Bader: *Science*, 101:591, 1942. 13. Waters and Stock: *Science*, 102:601, 1945. 14. Graham and Hoop: *Brit. J. Pharm. & Chemother.*, 3:84, 1948. 15. Anslow et al: *J. Pharm. & Exp. Therap.*, 91:224, 1947. 16. Horton et al: *J. Pharm. & Exp. Therap.*, 87:414, 1947. 17. Karnovsky et al: *J. Pharm. & Exp. Therap.*, 93:1, 1948.

Inhalation — 4-Hour Vapor Exposure
(Original Classes by H. F. Smyth & colleagues)

Category	Rats	Other Species
Extremely toxic	Ethylene imine (25—100 p.p.m.)[9]	Ethylene imine (10+ p.p.m.); guinea pigs[9]
Highly toxic	Phosgene (50—500 p.p.m.)[6] Nitrogen oxides (30—1000 p.p.m.)[2]	Nitrogen oxides (30—1000 p.p.m.); mice, guinea pigs, rabbits, cats[2]
Moderately toxic	Vinyl cyanide (153 p.p.m.)[3] HCN (200—480 p.p.m.)[7] SO_2 (400—3000 p.p.m.)[7] Methyl bromide (about 500 p.p.m.)	Vinyl cyanide (153 p.p.m.); guinea pigs, rats, monkeys, dogs[3]
Slightly toxic	Ethylene dichloride (1, 2 dichloroethane) (3000 p.p.m.)[1]	Ethylene dichloride (3000 p.p.m.); rabbits, guinea pigs, mice[1]
Practically non-toxic	Acetone (40,000 p.p.m.)[10]	Isopropyl benzene (2000 p.p.m.); mice[4]
Relatively harmless	Freon	Acetone (20,600 p.p.m.); mice[5]

1. Heppel et al: *J. Pharm. Exp. Therap.*, 84:53, 1945. 2. La Towsky, MacQuiddy, and Tollman: *J. Ind. Hyg. & Tox.*, 23:129, 1941. 3. Dudley, Sweeney and Miller: *J. Ind. Hyg. & Tox.*, 24:255, 1942. 4. Werner, Dunn, and von Oettingen: *J. Ind. Hyg. & Tox.*, 26:264, 1944. 5. Sayers et al: U.S.P.H.S. Bull. No. 185, 1929. 6. U. S. War Department, Medical Dept., U.S.A. (Vol. XIV), "Medical Aspects of Gas Warfare," 1926. 7. Sayers, Dalla Valle, and Yant: *Ind. Eng. Chem.*, 26:1251, 1934. 8. Fieldner, Katz, and Kinney: U. S. Bur. Mines, Techn. Papers, 272, 1921. 9. Carpenter, Smyth, and Shaffer: *J. Ind. Hyg. & Tox.*, 30:2, 1948. 10. Haggard, Greenberg, and Turner: *J. Ind. Hyg. & Tox.*, 26:133, 1944.

general, fairly simple compounds. Data on some species other than rats are included.

The acute toxic response to a four-hour vapor exposure has been used by Smyth and colleagues as a standard range-finding test. The accompanying table based on their original categories lists several possible examples of toxicity categories following the inhalation of compounds ranging from the extremely toxic ethylene imine to the practically non-toxic acetone or the relatively harmless freon. Specific information about the toxicity of freon is needed. As before, data on other species than rats are given.

The original intention had been to prepare a table with similar categories in which human fatalities could be listed. This has turned out to be a forlorn hope; consequently, the accompanying table lists, instead, some human fatalities following oral exposure in which the dose appears to have been fairly well known. If this tabulation does nothing more than direct attention to the paucity of information on this important point, it will have been well worth assembling. Physicians and toxicologists should record fatalities in the current literature when doses are known.

Skin Application (Rabbits)

(Table prepared by Henry F. Smyth, Jr., Charles P. Carpenter and Carrol S. Weil)

Extremely toxic	1 mg or less/kg	No examples
Highly toxic	1—50 mg/kg	TEPP (Tetraethyl pryophosphate)
Moderately toxic	50—500 mg/kg	Ethylene chlorhydrin, allyl alcohol
Slightly toxic	0.5—5 g/kg	Methyl acrylate, methyl cellosolve
Practically non-toxic	5—15 g/kg	CCl_4, dioxane, ethylene dichloride
Relatively harmless	15 g/kg	Di-2-ethyl hexyl phthalate, dimethyl phthalate, propylene glycol

Some Human Fatalities Following Oral Ingestion

Compound	Dose (gm/kg)	Total Ingestion (gm)	Reference
Mercuric chloride	0.001—0.002		Dunham: *Proc. Soc. Exp. Biol. & Med.*, 50:274, 1942.
Iodine	0.004—0.019	2—3	Dunham, op. cit.
Iodine			Sollmann, T.: "A Manual of Pharmacology," 1942, p. 958.
Acetanilide	0.005—0.250		Munch, Pratt, and Phillips: *J. Am. Pharm. Assn.*, 30:91, 1941.
Phenol	0.07 —0.14		Dunham, op. cit.
Phenol		125 (+ 31 g. camphor)	Miller: *Canad. M.A.J.*, 46:615, 1942.
Sodium salicylate	0.7		Ryder, Shaver, and Ferris: *New Eng. J. Med.*, 232:716, 1945.
NaF	0.006—0.008	0.7—1.0	Roholm: "Fluorine Intoxication," 1937:12.
DDT		120 cc. 5% soln.	Smith: *J.A.M.A.*, 136:469, 1948.
DDT		30 cc. 5% soln.	(infant) Hill and Robinson: *Brit. M. J.*, 2:845, 1945.
Aminophylline		0.6	Cadbury: *J.A.M.A.*, 70:19, 1948.
Aminophylline		1.0	Cadbury: op. cit.
Seconal		0.9	Wheelock and Fredeman: *J.A.M.A.*, 129: 130, 1948.
Nicotine		2.0 (tobacco)	Sollman, T.: op. cit., p. 403.
Nicotine		0.06 (nicotine)	Sollman, T.: op. cit., p. 403.
Sodium nitrite		2.3	Manby: Analyst, 70:50, 1945.
Sodium benzoate		6.0	Kinsey and Wright: *J. Lab. & Clin. Med.*, 29:188, 1944.
Potassium thiocyanate		15.0	Nichols: *Am. J. Med. Sci.*, 170:735, 1925.
Aspirin		10—30	Editorial: *New Orleans M. & S. J.*, 98: 179, 1945.
Aspirin		50	Charters: *Brit. M. J.*, 1:10, 1944.
Aspirin		81	Hopkins: *Lancet*, 248:145, 1945.
Hydroquinone and mono methyl para aminophenol sulfate		15 (73 hrs.)	Zeidman and Deutl: *Am. J. Med. Sci.*, 210:328, 1945.
		15 (92 hrs.)	Zeidman and Deutl: *Am. J. Med. Sci.*, 210:328, 1945.
Lead	5.0	20—50	Cantarow and Trumper: "Lead Poisoning." Baltimore, 1944, p. 95.
Methyl alcohol		120—140	Chambou: *Lyon Pharm.*, June, 1943.

Industrial Health Programs Pay Dividends

MANFRED BOWDITCH
Director of Health and Safety,
Lead Industries Association,
New York, New York

I TRUST that you will not be disappointed when I tell you that I have not come here for the purpose of citing statistics on the costs of industrial health programs, the extent of ill-health in industry or the dollar savings that may be effected through the impingement of such programs on this aggregate of ill-health. Sufficient reasons for not doing this are to me three basic facts.

The first of these is that, although a goodly number of such cost estimates have been published, among them the quite recent and useful one of the New Jersey Department of Health, it is still true that, because of the variables inherent in the problem, each program is in great degree a law unto itself in the matter of cost.

The second it that we *have* no worthwhile statistics on the extent or cost of ill-health in industry, let alone the costs of those physical and mental conditions which, while perhaps not so recognized, are anything but conducive to sound morale. And, in my opinion, we will never have such statistics, even as to those diseases properly designated as occupational, until they are made reportable by law as are tuberculosis and other communicable maladies. To point up this second fact, let me tell you of a little incident. The president of one of the member companies of our association had remarked to me that I should secure from our members reports of all their lead cases. When I broached this to the medical director of another of our companies, a far-flung and admirably operated organization, he came back with "How can *you* get them when I can't get them myself?"

My third and final fact is the obvious one that, with so frail a foundation as to costs, any thesis that I might seek to build in terms of dollar savings would have little validity.

So there will be no statistics. This does not mean, however, that I cannot express to you the most sincere conviction that any industrial health program, soundly conceived and administered in the light of the real needs of the company and its workers, will pay dividends quite as real as, if less tangible than, those which go out to the stockholders. I have that conviction and I hope to make clear to you why I have it.

Keynote address before Second Gulf Coast Regional Conference on Industrial Health, Houston, Texas, October 6, 1949.

Experiences in Industrial Health

BUT BEFORE I undertake this exposition, I ask your indulgence in one or two digressions. Firstly, as is the wont of us old gaffers, I would like to reminisce a bit. When I entered the employ of the Medical Department of the General Electric Company at Lynn, Massachusetts, in 1925, I became, so far as I have ever been able to determine, the first industrial hygienist ever to be employed on a full-time basis by any industry in this country. Honesty compels me to add that, being no tread-fearing angel, I undertook this work knowing next to nothing about industry and even less about hygiene. I was actually hard put to it to know how to describe myself, for industrial hygienists, now so numerous that they have their national and local associations and can hold regional meetings such as this one, were then very rare birds indeed. Yet despite these handicaps, it was almost no time before I was aware of two heart-warming satisfactions. I knew that I was doing something definitely worth the effort, and there was apparent evidence that what I was doing was improving morale.

If there are amongst us here any younger hygienists who sometimes feel that they are a bit behind the eight ball or are not wholly convinced that their efforts are appreciated, a couple of illustrations of what I have just said may have the germs of helpful suggestion. On thus finding myself a neophytic atom in the G.E. colossus, I got myself a little notebook and started wandering through the works, looking for situations that seemed to call for correction from some viewpoint of health. Having satisfied myself as to the proper corrective, I would approach the man in charge and ask him to have the change made. The answer was almost invariably, "Why sure!"—and the date was noted in my little book. When a month had gone by without visible change in the situation, Mr. Doe would be reminded that on such and such a date he had promised to do this or that. Sometimes a second month would elapse, with a second reminder, this time citing two dates, and after enough of this had gone on, I was gratified to learn that it was being said around the plant that, if you told Bowditch that you would do something, you might as well do it, as he would plague the daylights out of you until you did.

And then one day a woman worker turned up

in the dispensary complaining of back pain. I went to her work station and found that she was one of a group who were winding tape insulation onto quite sizeable coils. And I also noted that, though she was inches taller than any of her mates, the jig at which she worked was at the same height above the bench as all the rest. No appreciable gray matter nor cost were involved in raising the jig to a proper height, or in suggesting a less arduous method of winding, but it was good to learn that the pain had disappeared, and better yet to have this worker say to me one day, "You don't know what it means to know that somebody in the plant cares about such things." Is there any one of us here who does not share my conviction that such simply accomplished improvements pay dividends out of all proportion to their cost?

Industrial Health Programs Lagging

YET WITH this conviction of mine goes another, that industry as a whole has hardly more than begun to appreciate the profit potentialities of comprehensive health programs. Indeed, if this were not so, there would be little occasion for a paper such as this. So let us try to determine why health work in industry has lagged so far behind the industrial revolution itself, for only by so doing may we hope to stimulate it to more rapid growth. This cannot but involve some criticism of the several parties to the problem, in which I assure you that I mean to be entirely fair.

First of all, it is axiomatic that a health program in industry must be under medical guidance, for neither the hygienist nor the nurse is adequate to the situation alone. Such guidance, one might think, should be easy to secure, for there are now many full-time doctors in industry, many more who serve industry on a part-time basis, and still others available as consultants in industrial areas. Why, then, is it not more common? One reason, I believe, is that the concept of industrial medicine as little more than traumatic surgery is still regrettably persistent. I subscribed to the dictum of DR. ALICE HAMILTON when she said many years ago that the company employing a thousand workers should have a full-time doctor, and I still subscribe to it, with perhaps the more modern proviso that it be a half-time doctor and a part- or full-time hygienist or nurse. And I will go a step further and say that if this doctor or team of medical workers charged with responsibility for the health of a thousand industrially employed men and women do not find their time more than fully occupied, some change in personnel is indicated.

In short, it is my considered opinion that all too few industrial medical men are really health-minded. For this we must hold the medical schools at least in part responsible. I do not pretend to know too much about medical education, but I have taught in two of our leading schools of medicine, have informed myself of the instruction given at a number of others, and think it may in all honesty be said that, as far as undergraduate teaching of industrial or occupational subjects is concerned, it is in most cases quite lamentably inadequate. When we turn to post-graduate courses in industrial hygiene and medicine, the picture is somewhat brighter; yet even here, to judge by reports of enrollment at three well-known schools that came to me only the other day, it is none too rosy.

The old reliable law of supply and demand seems to be working here. What incentive is there to the young and aspiring M.D. to spend years of his youth and large amounts of his none-too-ready cash in perfecting himself for work which may well be rewarded, despite his competence, with earnings far less than he could gain in private practice? This question brings us to the steps of industry itself, and it is up these steps that we must pass in seeking to bring about the enlightenment that will have to come before anything approaching universally adequate health programs is attained in our manufacturing establishments.

What are the major difficulties here? One, I believe, is continuance in some management quarters of the old idea that medical service is a necessary evil, to be secured at the lowest possible cost. If Dr. Jones will do the job for five hundred dollars less than Dr. Brown, Dr. Jones is obviously the man for the job. Another is the inability of the front office, which is used to laying down the law to its production departments, to conceive of dealing with its medical department in any other way. Yet most doctors who are really worth their salt are pretty independent critters and have no intention of being told by a mere layman how they should conduct their work. It is my firm belief that, if the managers of all our larger industries, in seeking medical and health service, would raise their sights in terms of professional ability, salary and that intangible called personality, to the level achieved by some that I could mention, and having done so, would give their doctors full front-office backing but otherwise leave them alone, the professions, the schools, the workers and the corporations themselves would all be the gainers.

Labor, in the past, has had relatively little to say about health programs in industry, but this situation is changing. With the increased

participation of the workers themselves in the solution of their own hygienic problems, it is to be hoped that there will come an ever clearer realization that, when health is mixed with politics, the former is invariably the loser.

Having been a state-employed industrial health worker for fifteen years, and therefore perhaps knowing whereof I speak, I venture to suggest that, despite their obvious importance and accomplishments in the development of industrial hygiene services, somewhat the same hope might be expressed with regard to the governmental agencies. All of us are, I am sure, painfully aware of the prolonged jurisdictional wrangling that has marred the record on both federal and state levels, and all of us who have the cause of industrial health at heart must be glad of the apparent lessening of this quite indefensible bickering.

Advances in Industrial Health

I SEEM to have managed to throw quite a few bricks. Now, with your permission, I would like to pin on some well-merited posies in each of the above categories, for in at least partial compensation for the over-all lag which I am perhaps too prone to deplore, there have been many truly remarkable advances, for which due credit should be given.

Among the industrial physicians there are of course a goodly number who constitute the true leaven of the loaf. It was DR. JOHN J. WITTMER of New York's Consolidated Edison Company who said recently, "It is certainly the responsibility of industry to see to it that 'manpower' receives such care and consideration as is appropriate to its top position in the scheme of our industrial economy. I can't conceive of a plant manager in this day and age, ordering, installing and operating mechanical equipment without (1) determining exactly what was required of the equipment, (2) securing the best equipment for his needs, (3) having it installed by competent mechanics, and (4) establishing an operational maintenance program to insure optimal efficiency and useful life. Is there any moral or practical reason why we should do less for the individual, without whom the equipment could not have existed, let alone be operated?"

And another doctor, whom I am not at liberty to name, wrote me not long ago about two lead cases, saying of one that he "was annealing steel wires in lead baths, but in addition drinking leaded water out of his own faucets in a country home." To say that such etiological detective work is a credit to the profession seems to me but the faintest sort of praise.

I need not be told of the extreme difficulties faced by the medical schools in seeking to fit industrial medical instruction into an ever more crowded curriculum, and I am aware of the success that has met these efforts in some quarters. Confining mention to examples of medical school activity within the state of Texas, the industrial hygiene research laboratory being established by DR. NAU at Galveston bids fair to be a most valuable addition to a group of institutions of which we have all too few, and the privilege of learning at first hand from DR. KEMP of his plans for the future of industrial medical teaching and research at Baylor has added not a little to the interest of my first visit to Houston.

As to the industries, I have already indicated that there are those whose sights in terms of medical and health service are at a commendably high level. Since so revolutionary a change could not have come about without the sanction of an enlightened management, it seems appropriate to mention here the transfer last winter of the Socony-Vacuum Oil Company's human relations activities from its industrial relations department to its medical department, the purpose being to permit the traditionally confidential doctor-patient relationship to aid in solving personal problems adversely affecting the work of the company's employees. And as an example of excellent yet economical co-operative health activity for the benefit of industry at large, I would like to cite the fact that the smaller companies may secure the benefits of membership in the Industrial Hygiene Foundation of America for as little as fifty dollars a year.

That labor is now ready to join with management and medicine in advancing the cause of health and safety in industry on a truly sound basis is evidenced by the Washington meetings being held in an effort to establish a permanent conference for that purpose, with representatives of the American Federation of Labor, The Congress of Industrial Organizations, the National Association of Manufacturers, the U.S. Chamber of Commerce and the American Medical Association participating. Judging from what one of the medical members of this group has told me, the labor approach to the problem is on a high plane.

It seems most unlikely that the recently created National Advisory Committee on Industrial Health, with ten distinguished members, can fail to notably benefit the Federal Government's industrial hygiene activities. Among the state and local units, of which there are fifty-eight in all, it can hardly be expected that all will operate at the same high level of efficiency. Many are, however, doing excellent work, and I consider it a duty of my present position to bring about cordial and mutually profitable relations between these agencies

and our member companies wherever possible. I have been particularly impressed by the Kentucky industrial health survey now being conducted by MR. W. W. STALKER, director of the division in that state.

I hope that, despite the rather rambling nature of my remarks, I have succeeded in making evident my conviction that industrial health programs *do* pay dividends. I realize, however, that, having now been engaged in the promotion of industrial health for nearly twenty-five years, I may be suspected of some little prejudice in its favor. It therefore seems appropriate that I should quote, in conclusion, from two of the men who pay for these programs, for if *they* are for them, as the executive heads of outstanding industrial organizations, it must be for reasons far more practical than mere prejudice. I quote first from an address by MR. WILLIAM B. GIVEN, president of the American Brake Shoe Company, who said at a meeting of the Industrial Hygiene Foundation:

"How effectively or how badly a Medical Department functions should be one of the many useful yardsticks for directors when they are wondering whether the company needs a new head. After all, the most important part directors have to play in management is promptly removing the senior officer when over-all he is found not up to his job—yes, and without wasting time about it.

"By the same token, with today's competition for the most intelligent and efficient workers, stockholders cannot long afford directors who do not realize the importance of top health and safety conditions in their company's plants, nor managements which do not spend whatever money is necessary to give plant people the maximum of health and safety assurance."

And finally, I quote MR. ANDREW FLETCHER, president of the St. Joseph Lead Company, who on a similar occasion spoke as follows:

"Good health is the most important asset in life. I know of no company that has improved working and living conditions of its employees that has not obtained satisfactory returns in dollars as well as in human happiness."

American Industrial Hygiene Association
—News of the Local Sections—

Georgia Section

ON OCTOBER 13, the annual dinner meeting was held at Georgia School of Technology. The meeting was addressed by MANFRED BOWDITCH, Director of Health and Safety, Lead Industries Association, New York City on his experiences in a talk entitled "Twenty-four Years of Industrial Hygiene."

Michigan Section

ON NOVEMBER 15, the MICHIGAN INDUSTRIAL HYGIENE SOCIETY was addressed by DR. PAUL C. CAMPBELL, JR., of the Dermatoses Section of the U.S. Public Health Service, Industrial Hygiene Division. DR. CAMPBELL reported on the investigative work which he has conducted in many industries and particularly on a search for less hazardous chemicals for use in lithography.

Metropolitan New York Section

ON NOVEMBER 2, 1949, VICTOR K. LAMER, PH.D., Professor of Chemistry, Columbia University, gave a paper entitled, "Aerosols" in which he discussed briefly the problems and techniques involved in the generation, size measurement and use of monodispersed aerosols including a consideration of lung retention as a function of particle size.

New England Section

FOLLOWING the annual conference held in Boston on October 28, the following officers were elected: Chairman, DR. F. J. VINTINNER, Division of Industrial Hygiene, New Hampshire State Board of Health, Concord, New Hampshire; Secretary-Treasurer, DR. LESLIE SILVERMAN, Harvard School of Public Health.

Philadelphia Section

ON NOVEMBER 2, GEORGE D. CLAYTON, Chief of the Atmospheric Pollution Unit of the U.S. Public Health Service talked to the section on "Industrial Hygiene in the Study of Atmospheric Pollution."

Pittsburgh Section

ON NOVEMBER 29, H. H. SCHRENK, PH.D., Research Director, Industrial Hygiene Foundation, spoke at the Section meeting on the subject "Air Pollution."

Western New York Section

THIS SECTION has just been organized and is to hold its meetings in Rochester since a large portion of the members live in this vicinity. The next issue of the Quarterly will carry a list of the first officers and the program for the remainder of the year.